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(54) PISTON AND CYLINDER DEVICE WITH LOCKABLE PISTON

(71) We, MASCHINENFABRIK ANTON RUTHMANN, of Am Bahnhof, D-4423 Gescher, a German Company, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a piston and cylinder device having a first piston and associated rod which can be secured relative to the cylinder by means of a locking arrangement, and a second piston located within the same cylinder, whereby both pistons are connected by transmission means to the locking arrangement which, in the event of movement of one piston relative to the other, operates the locking arrangement.

Such a piston and cylinder device is described in German Offenlegungsschrift No. 2502381. In such a device, locking means are provided between the two pistons or piston halves, which means are forced radially against the inner wall of the cylinder to effect locking, in the event of failure of the device. As the inner wall of the cylinder is smooth and covered with film of hydraulic oil which is lubricating, the locking means are unable to produce a very strong holding force even under conditions of very high application of pressure. Furthermore, the application force is produced by spring-loading means which must be small and therefore only able to exert a limited application pressure owing to the restricted space between the pistons. Shock-like impact, arising for instance in the event of fracture of a component forming part of the arrangement, cannot be absorbed by such known devices. Furthermore, the above-described locking means are liable to damage the cylinder inner wall or at least to induce extreme wear.

An object of the present invention is to provide a piston and cylinder device with lockable piston, which can withstand high loads in the locked condition.

According to the present invention, there is provided a piston and cylinder device comprising a cylinder, a first piston and associated rod in the cylinder, a locking arrangement operable to lock the first piston relative to the cylinder, a second piston disposed in the cylinder, and transmission means connecting the pistons with the locking arrangement so that, in the event of movement of one piston relative to the other, the locking arrangement is operated by the transmission means, wherein the locking arrangement is operated by the transmission means, wherein the locking arrangement includes a part fixed with respect to the cylinder and a locking component coupled to the first piston and which is firmly secured to said fixed part in the operated condition of the locking arrangement.

As a result of the locking arrangement not operating on the inner wall of the cylinder inner wall but on an additional part secured to the cylinder, the components which are subjected to traction or pressure-forces may be designed in an optimum manner according to the requirements, thereby offering purchase surfaces to the locking arrangement, by means of which the loads can be admitted, far in excess of the hydraulic capacities of the piston and cylinder device. Any damage or wear of the inner wall of the cylinder is thus completely eliminated.

In order to allow relative movement between pistons the space between the pistons may be connected to atmosphere or other low pressure medium via the inside of a hollow piston rod. The discharge of oil through the hollow piston rod also serves as an indicator of internal oil leakages.

Furthermore, the locking arrangement may be arranged within or outside the cylinder, the arrangement outside the cylinder offering the advantage of easy maintenance and a more simple design.

The transmission means may include a switch, valve, rod arrangement and/or a lever.

A particularly simple design within the cylinder is achieved by the use of a tubular piston rod, inside which the piston rod of the other piston is slidable.

The piston rods may extend from the same end or from opposite ends of the cylinder.

The part fixed to the cylinder may be a rack. The rack may be disposed externally of the cylinder. If desired, the rack may be disposed coaxially within the cylinder and surrounded by the piston rod or rods.

In a particularly simple mechanical design, the locking component may include a lever having one end pivotally connected with the first

piston, an intermediate portion pivotally connected with the second piston and an opposite end carrying a member engageable with the fixed part of the locking arrangement.

In the event of a directional lock being arranged on the piston and cylinder device, i.e. a lock having a greater effectiveness in one direction than the other, it is advantageous to provide a third piston within the cylinder, whereby the first piston is located between the second and third pistons, the said first and second pistons being connected by a first locking arrangement, and the first and third piston being connected by a second locking arrangement, and each locking arrangement only being effective in one direction of movement of the piston. In order to achieve a space-saving construction, the piston rods of the second and third pistons may be in the form of adjacent half-shafts.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is a part section through one embodiment of piston and cylinder device with a mechanically controlled lock operative in one direction;

Figure 2 is a part section through a second embodiment of piston and cylinder device with mechanically controlled directional lock operative in the opposite direction;

Figure 3 is a part section through a third embodiment of piston and cylinder device with two mechanically controlled directional locks acting in opposite directions; and

Figure 4 is a side view of a fourth embodiment of piston and cylinder device with a locking lever surrounding the cylinder.

Referring now to Figure 1 of the drawings, the piston and cylinder device comprises a cylinder 25 in which is disposed a piston divided into two consecutive piston halves. The piston-half facing a hollow, working piston-rod 3 forms a first piston 1 (working piston) which is connected with the piston rod 3. The piston rod 3 projects from the cylinder 25 through a seal 19 at a head 13 of the cylinder 25 and terminates in a bifurcated connection head 4. At a face of the first piston 1 facing away from the piston rod 3 is located a face of a second piston 2*a* (switching piston) provided with its piston-rod 5*a* extending through the working piston rod 3 and projecting from it in the region of the connection head 4. For enabling it to be secured to the working piston rod 3, the correction head 4 has a plate 33 secured vertically to the working piston rod. At least one side of the plate 33 projects beyond the outer diameter of the cylinder 25 in order to provide a securing point for a rod 11 extending parallel to and externally of the cylinder 25. A rod 8*a* slides within a guide 27 secured to the head 13. The rod 11 is somewhat longer than the cavity in the cylinder 25 and at an end thereof opposite the correction head 4 has a pivot point 10 to which one end of a two-sided locking lever 9*a* is connected.

On the side of the plate 33 remote from the cylinder 25, a lever 6*a* extends diametrically over the plate 33 and has one end thereof pivoted at an articulation point 7 on the plate 33 and the other end thereof pivotally connected at 24 to the rod 8*a* which extends parallel to the rod 11. The rod 8*a* is pivoted to the centre of the locking lever 9*a*: To enable adjustment and to accommodate for slight movement of the pivot point 24 between the lever 6*a* and the rod 8*a*, the lever 6*a* is not pivotally attached directly to the rod 8*a* but to a ring 27*a* which is held between two springs 15 located on rod 8*a* and secured by two adjustable nuts.

In order to transmit the movement of the second piston 2*a* to the locking lever 9*a*, the piston rod 5*a* is pivotally connected at its part projecting from the working piston rod 3 with the lever 6*a*, at a point which is off-centre and closer to the pivot point 7 than to the point 24. At its end opposite the pivot point 10, the locking lever 9*a* has a stub 22 which can be engaged with a toothed rack 12*a* upon pivoting of the lever 9*a*. At the level of the rod 8*a*, the rack 12*a* is parallel to the axis of the cylinder 25 and has teeth indicating the cylinder travel. The rack 12*a* is secured at one of its ends to the guide 27 in the region of the cylinder head 13, and at the other of its ends to a base 26 of the cylinder by a clip 14.

The pistons 1 and 2*a* have annular seals 21 and 29, respectively, and the second piston 2*a* also has a sliding ring 16 which is pressed against the wall of the cylinder 25 by means of a clamping arrangement 17, in order to produce an accurately gauged friction which should be greater than that of the first piston 1.

In the event of the piston and cylinder device operating under traction, i.e. with the piston rod 3 being retracted, oil is introduced into the cylinder cavity 28 on the left hand side of the piston 1, as viewed in Figure 1, and is expelled from the opposing cylinder cavity 30, this being effected by way of fluid connections points 18 and 23, respectively. Providing that no leakage occurs in the piston and cylinder device or in the connections or the connected units, pistons 1 and 2*a* remain closely together, and the locking-lever 9*a* moves parallel with the pistons in a disposition in which it is perpendicular to the axis of the cylinder 25. However, in the event of a leakage, the pressure in the cylinder cavity 28 falls, and the first piston 1 moves away from the second piston 2*a*. Similarly, the rod 11 connected to the first piston 1 is moved, so that the lower part of the locking-lever 9*a* is moved to the left as viewed in Figure 1 and the upper part moves towards the right as viewed in Figure 1. In so doing the stub 22 engages the toothed rack 12*a* and thus prevents any further movement of the piston 1.

While the first piston 1 moves away from the

second piston 2*a*, air is sucked through an annular space 31 defined in the piston rod 3 around the piston rod 5*a* and into the space which has formed between the pistons 1*a* and 2*a*. As soon as the required pressure level has been restored in the cylinder cavity 28, the first piston 1 moves until it bears against the second piston 2*a* once again, and the lock is automatically released.

The piston and cylinder device of Figure 2 is the same as that of Figure 1 except that the piston rod 3 does not operate under traction but under compression, and in consequence second piston 2*b* is disposed on the side of the first piston 1 which faces the piston rod 3. Piston rod 5*b* secured to the second piston 2*b* is located inside the tubular working piston rod 3 in this embodiment also, and is connected with the second piston 2*b* by means of a bolt or pin (not shown) which extends through a slot in the working piston rod 3. Whereas, in the first embodiment, the teeth of the rack 12 incline slightly in the opposing direction to traction force, the teeth on rack 12*b* are inclined in the opposite sense in order to withstand compression forces with greater safety.

The third embodiment, as shown in Figure 3, is capable of operating with pressure drops on either side of the pistons, and has a piston divided into three parts, or, in effect, three pistons. The middle piston 1 is the effective working piston, being connected with the piston rod 3 leading to the connection head 4. Inside the piston rod 3 are disposed piston rods 5*a* and 5*b* of the other two pistons 2*a* and 2*b*. Each rod 5*a*, 5*b* is of a semi-circular section, and is provided with a respective lever 6*a*, 6*b* to its end. The levers 6*a* and 6*b* transmit the movement of the piston rods 5*a* and 6*b* to the rods 8*a* and 8*b* respectively so as to move repective locking levers 9*a* and 9*b*. In addition to these three embodiments numerous variations in designs can be visualised. The basic principle of these three embodiments is the arrangement of at least one piston of the same diameter next to the working piston, viz. the sub-division of the working piston into two- or three- parts, whereby the pistons move synchronously at a distance from each other or close together during trouble free operation. It is only in the event of a pressure drop induced by a failure that more pressure-medium flows in one cylinder cavity than in the other cylinder cavity, that the pistons are separated. This movement of one piston relative to the other can be detected by an arrangement which may be located inside the cylinder, inside the pistons, between the pistons or outside the cylinder. As an example, electric, hydraulic or pneumatic switches may be disposed within or between pistons, recording the separation of the pistons from each other (viz, by direct recording of the changing gap or by perceiving the pressure change between the pistons), and triggering a mechanical, hydraulic, pneumatic or magnetic locking arrangement which secures the working piston. The locking arrangement may be located within the cylinder, for example inside or between the pistons, and for instance induce a locking action against a part fixed to the cylinder wall or against a coaxial or offset rod (viz. toothed rack or punched rod) guided through the hollow piston rod. The signal emitted by the switch may also be emitted to the outside, for instance through the inside of the piston rod, through the tubular piston rod acting for example as a conductor, or through a conductor being located within the piston rod. In that case, a locking arrangement on the outside of the cylinder is released by the signal. Finally, the medium sucked in by the hollow piston rod, and discharged on parting of the pistons or piston-components from each other may control a pressure-responding arrangement (boot, diaphragm) connected to the discharge aperture of the piston-rod and actuating the locking arrangement mechanically, electrically, hydraulically or pneumatically.

The piston and cylinder device according to the invention may be arranged with particular ease between a pivoted support and a cradle pivoted therefrom so as to ensure that it remains permanently horizontal, the piston and cylinder device being driven by a second piston and cylinder device, located between a lower end of the pivoted support and a bearing of the pivoted support.

In a fourth embodiment, as illustrated in Figure 4, the locking lever 9*a* is provided in two parts, surrounding the cylinder 25 on both sides, thus ensuring a particularly compact design. The toothed rack 12*a* is fitted directly to the cylinder 25, and two control rods 11 leading to the first piston 1 are pivoted approximately at the middle of the locking lever 9*a*, thus moving through a plane passing through the cylinder axis and perpendicular to the plane of the toothed rack 12*a*. Rods 11 may thus be pivotally attached to the locking member 9*a* on either side of the cylinder 25, the rods being located on diametrically opposite sides of the cylinder 25. A flat section 34 secured to the cylinder 25 diametrically opposite the toothed rack 12*a* defines a slot parallel to the axis of the cylinder and serves as a counter-bearing for the locking lever 9*a*. The rods 11 are arranged in such a manner that, when the locking lever 9*a* is engaged the axis of the piston-rod 3 and the axes of rods 11 lie in the same plane. In that manner, the rods 11 are stressed only under traction or under compression, and do not have to withstand any bending moment.

WHAT WE CLAIM IS:—

1. A piston and cylinder device comprising a cylinder, a first piston and associated rod in the cylinder, a locking arrangement operable to lock the first piston relative to the cylinder, a second piston disposed in the cylinder, and transmission means connecting the pistons with the locking arrangement so that, in the event of

movement of one piston relative to the other, the locking arrangement is operated by the transmission means, wherein the locking arrangement includes a part fixed with respect to the cylinder, and a locking component coupled to the first piston and which is firmly secured to said fixed part in the operated condition of the locking arrangement.

2. A device as claimed in Claim 1, wherein the transmission means includes a switch, valve, rod arrangement and/or a lever.

3. A device as claimed in Claim 1 or 2, wherein the locking arrangement is connected *via* the transmission means with the piston rod of the first piston and a piston rod of the second piston.

4. A device as claimed in any preceding Claim, wherein the locking arrangement is a friction or mechanical interlocking device or an hydraulic, pneumatic, or magnetic braking or holding device.

5. A device as claimed in any preceding Claim, wherein the space between the pistons is connected to atmosphere or another low pressure medium through the piston-rod or one of the piston rods.

6. A device as claimed in Claim 3 or Claim 4 or 5 when appended to Claim 3, wherein the piston rods extend from the cylinder at opposite ends thereof.

7. A device as claimed in Claim 3 or Claim 4 or 5 when appended to Claim 3, wherein one of the piston rods is a tube within which the other piston rod is slidably disposed.

8. A device as claimed in any preceding Claim, wherein the part firmly secured to the cylinder is a toothed rack extending parallel with the axis of the cylinder.

9. A device as claimed in Claim 8, wherein the toothed rack is disposed externally of the cylinder.

10. A device as claimed in Claim 8, wherein the toothed rack is disposed inside the cylinder.

11. A device as claimed in Claim 10, wherein the toothed rack is coaxially disposed within the cylinder and is surrounded by the piston rod or rods.

12. A device as claimed in any preceding Claim, wherein the transmission means includes a lever connected to a piston rod of the second piston and operably connected with the locking component.

13. A device as claimed in Claim 12, wherein said lever is adjustably connected with a rod disposed between the lever and the locking component.

14. A device as claimed in any preceding Claim, wherein the locking component includes a locking lever having one end pivotally connected with the first piston, an intermediate portion pivotally connected with the second piston and an opposite end carrying a member engageable with the fixed part of the locking arrangement.

15. A device as claimed in any preceding Claim, wherein a third piston is disposed within the cylinder on the opposite side of the first piston to the second piston, the first and second pistons being connected by a first locking arrangement for the first piston and the first and third pistons being connected by a second locking arrangement for the first piston and each locking arrangement being arranged to lock only in one direction of movement of the piston.

16. A device as claimed in Claim 15, wherein the piston rods of the second and third pistons are adjacent half-shafts.

17. A device as claimed in any one of Claims 14 to 16, when appended to Claim 8, wherein the toothed rack bears directly on the external wall of the cylinder or is formed thereby, and said locking lever extends at least partially across the cylinder.

18. A device as claimed in Claim 17, wherein said locking lever is disposed on both sides of the cylinder and a transmission rod or each side of the cylinder has one of its ends secured to the locking lever and the other of its ends connected to the piston rod of the first piston.

19. A piston and cylinder device substantially as hereinbefore described with reference to Figure 1 or Figure 2 or Figure 3 or Figure 4 of the accompanying drawings.

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1586621 COMPLETE SPECIFICATION
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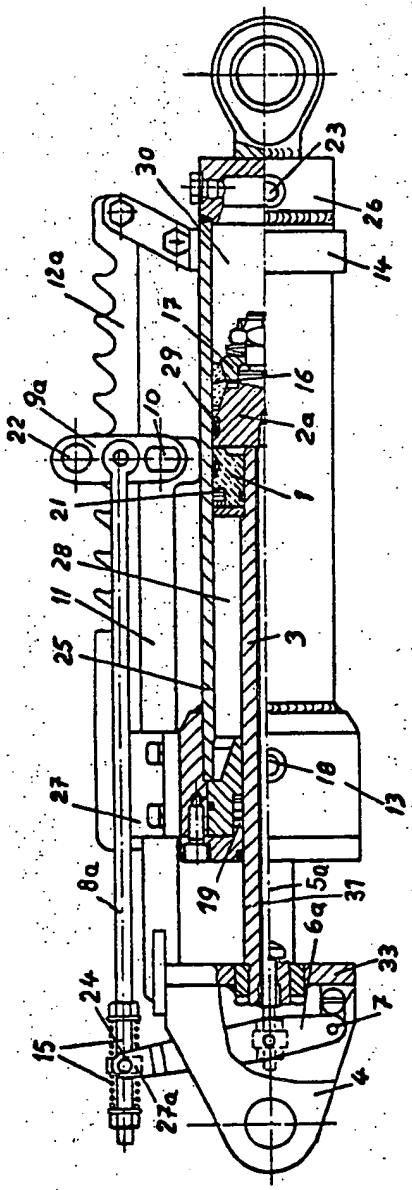

Fig.1

1586621 COMPLETE SPECIFICATION
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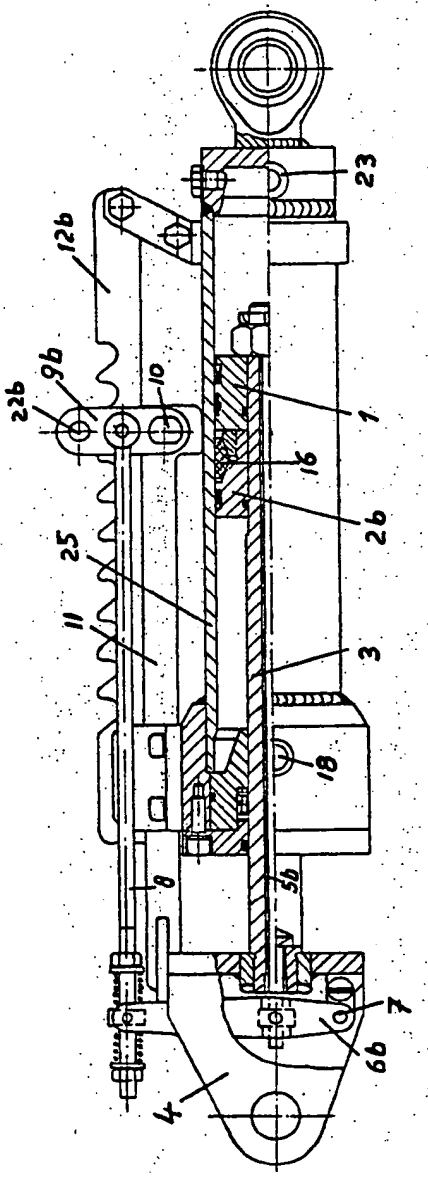

Fig.2

1586621 COMPLETE SPECIFICATION
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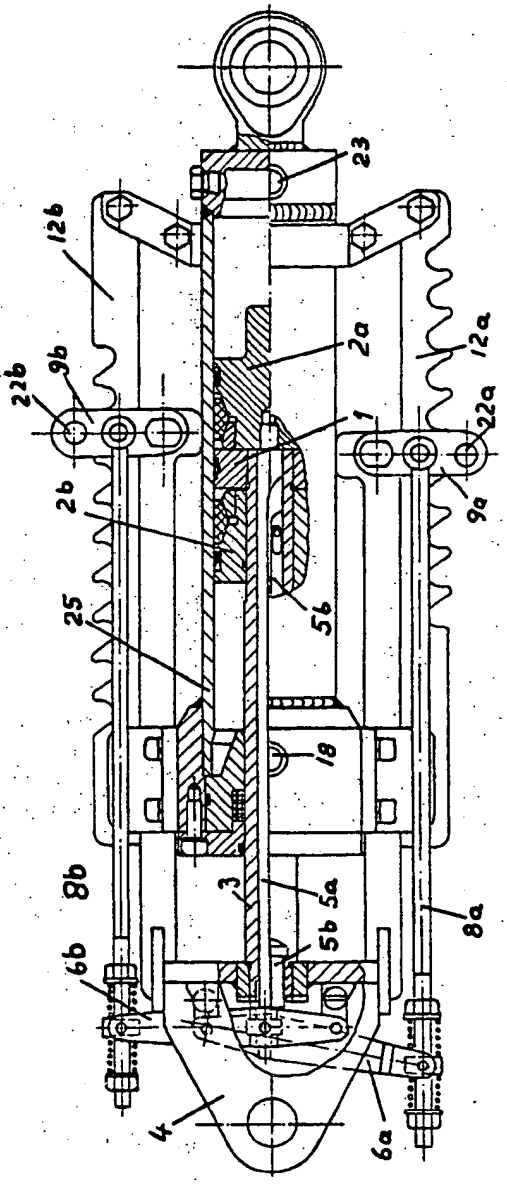

Fig.3

1586621 COMPLETE SPECIFICATION
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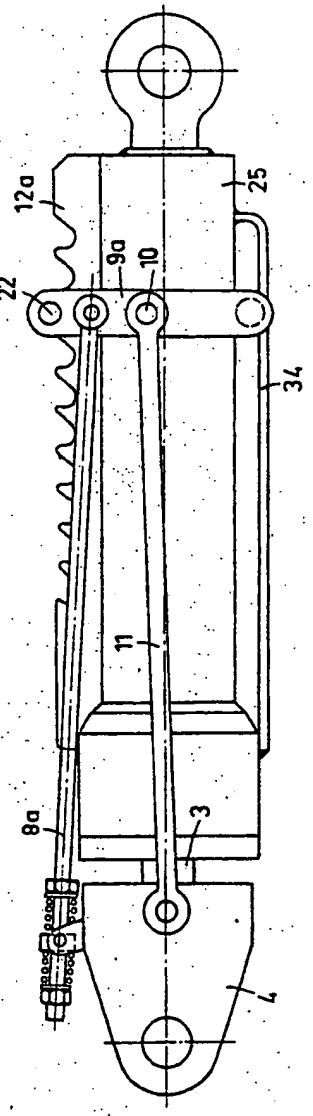

Fig.4